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OBJECTIVES AND EVALUATION--AN INDIVIDUALIZED SYSTEM.

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THE MOST IMPORTANT FACTOR IN IMPROVING EDUCATIONAL ATTAINMENT IS THE ANALYSIS AND SPECIFICATION OF EDUCATIONAL OBJECTIVES AND LEARNING OUTCOMES. THE DEFINITION OF INSTRUCTIONAL OBJECTIVES FOR THE CURRICULUM DESIGNER, TEACHER, AND STUDENT SERVES AS A GUIDE FOR ATTAINING GOALS. WHEN INFORMATION ABOUT STUDENT PERFORMANCE IS THE BASIS FOR CURRICULUM DESIGN, STUDENT PERFORMANCE MUST BE DIAGNOSED BEYOND THE MEASUREMENT OF STUDENT STANDING WITHIN A GROUP. WORK NEEDS TO BE DONE IN DEVELOPING CRITERION-REFERENCED TESTS IN ORDER TO ASSESS THE OUTCOMES OF LEARNING. THIS ARTICLE IS A REPRINT FROM "SCIENCE EDUCATION NEWS," JUNE 1967. (MC)

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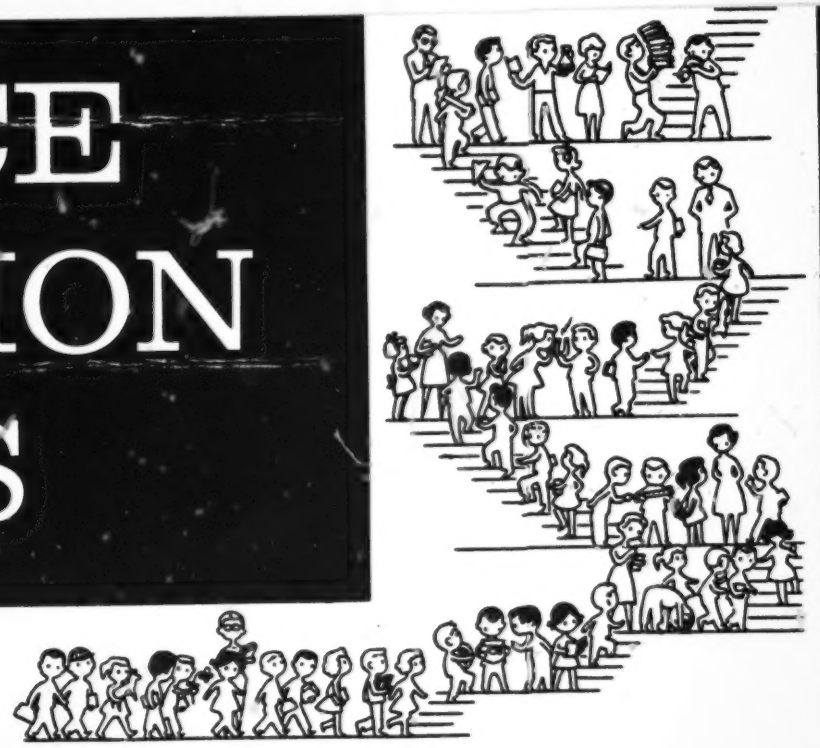

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Objectives and Evaluation

During the past decade of major effort devoted to the improvement of education, and science education in particular, there has been an increasing interest in and concern about evaluation of the effectiveness of new courses, new curricular sequences, and modified teaching procedures. School people ask for comparisons of the "new" with the "more traditional," but there has been little to give them. Comparisons are exceedingly difficult to come by unless they can be made in terms of measures of achievement of common and specified objectives of the programs subject to comparison.

There have been differences of opinion among scientists about the usefulness of statements of objectives and the evaluation of their achievement, and certainly about the nature of the statements and the methods of evaluation. Some apparently fear that attention to statements of objectives and construction of evaluation strategies im early stages of course development may actually hamper innovation. Others have stated objectives amd prepared evaluation instruments as first steps im course development. Still others take positions at numerous points between these extremes.

Two psychologists, an education professor, a state education department staff member, and a course content project staff member have been invited to present in this issue a statement on behavioral objectives and evaluation, with freedom to develop their statements in a manner chosen by them. We believe that these statements make a significant contribution to the current evaluation debate and to a resolution of some of the related critical issues.

JOHN R. MAYOR
Director of Education
AAAS

An Individualized System

Over the past decade, work on curriculum design, with respect to both the content and the teaching of content, has been a major response to the growing requirements and demands for modernization in education.[1] The joint activity of subject matter scholars and behavioral scientists is particularly evident. Instructional design has become a joint endeavor of these two groups because either alone is inadequate for the task, and the teacher requires this joint input so that effective tools will be available.

Coinciding with this effort has been the educator's concern with adapting instruction to the needs of the individual student. This is a familiar theme which has been repeated many times and which provides the justification and basic premise for many current innovations and experiments. However, both operating and research experience indicate that certain fundamental changes in school operation will have to take place if progress is to occur. In adapting an educational plan to the individual, conventional boundaries in terms of grade levels and semester units must be replaced by individual progress along a continuum of increasing subject-matter competence. Implicit in and fundamental to an

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individualized system are two key operations: (1) the analysis and definition of educational objectives which are used as guidelines for setting up each student's program of study; and (2) the evaluation and diagnosis of student performance so that amount and kind of instruction can be adapted to his particular requirements. Implementing these operations in the instructional enterprise requires discipline by educators, as well as intelligent and imaginative use for effective application and continuous improvement.[1]

Educational Objectives

Though the objectives of one curriculum designer or one teacher (including values) may not be the same, the single most important factor that can contribute most immediately to improvement in educational attainment is the analysis and specification of educational objectives and learning outcomes. The following points elaborate on this statement and indicate the impact of the specification of objectives upon the educational process:

(1) The definition of instructional objectives instructs the curriculum designer and the teacher how to proceed. Vague specification of the desired competence level leaves the teacher with little concrete information about what to look for in student performance and about what to provide the student to attain this performance. Recognition of the details of the competence to be acquired permits the teacher to guide some students to reach this level and to quickly react to the students who surpass it.

The interaction between the specification of objectives and experience in teaching frequently provides a basis for a redefinition of objectives. As the curriculum designer and teacher see what really is possible, they may see more clearly the kinds of instruction and performance capabilities that students need in addition to those initially considered in lesson planning. The process of clarifying goals, working toward them, appraising progress, reexamining the objectives, modifying the instructional procedures to achieve goals, and clarifying the objectives themselves in the light of experience and data should be a continuous process. This process, however, has little focus in the absence of initially specified objectives.

A related point is that regardless of the way a subject matter is structured there is usually present some hierarchy of subobjectives, which indicates that certain performances must be present as a basis for learning subsequent performances. This hierarchy may be influenced by the properties of different tasks and by individual differences; nevertheless, the absence of prerequisite competence in a sequence of instruction dooms many students to failure. Specification of objectives permits identification and diagnosis of entering competence as well as terminal performance in a course of study.

(2) Knowledge of objectives by the student gives him a goal to attain; such knowledge is instructive and motivating. It permits the student to monitor his partial successes and failures and to adjust and organize learning resources for himself. It is difficult for him to do this without prior identification of what is meant by competence. This competence can be learning to add, or the more complex behavior of recognizing that the solution to a problem may involve many steps and that the solution itself has many answers.

(3) As in other lines of endeavor, teachers require frequent information about the results of their work so that they can adjust their practices accordingly. Teachers need standards by which to judge themselves and by which society can judge their effectiveness. This work, and the task of assessment and measurement, is facilitated by the specification of student behavior which can be observed and generally agreed upon. For the most part, what can be measured in education are the short term goals which are attained in school, most frequently in terms of a year's work in a class. It is only hypothesized that the performance at the end of a school year or at the end of so many years of schooling is related to long-term goals about the effectiveness of the student in society and his profession. Detailed investigation of the relationship between performance during and at the end of schooling and performance in later life needs to take place. This kind of investigation requires specification of performance at both points.

(4) The exercise of specifying objectives points up the inadequacies of present knowledge of the educational process. It might be said of a particular objective that, "This involves only rote learning; I really mean something else." The burden is then to say what else is meant and how to recognize its presence in our students. In the absence of such an exercise, lesson designers and teachers find themselves settling for the rote objective because there has been little attempt to analyze the behavioral components of what they have in mind. If, indeed, complex reasoning and openendedness are desirable aspects of human behavior, then this needs to be a recognized and measurable goal. Overly general, non-performance-based objectives may force us to settle for what can be easily expressed and measured.

The fear of many educators that the detailed specification of objectives forces us to work with only simple behaviors which can be forced into measurable and observable terms is, indeed, an incorrect notion. The situation rather is, that if we do not attempt to specify the complex processes we want to see in the student, then we are in danger of omitting them and following the path of least effort toward teaching more easily observable and trivial behavior. We should specify, as best we can in science education, that we are interested in such behaviors as reasoning skills, skill in selecting fruitful hypotheses, skill in formulating problems to be solved by scientific experiment, scientific patience and perseverance, tolerance for ambiguity and scientific curiosity.

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[1] For more detail on one such system of individualized instruction, see C. M. Lindvall and J. O. Bolvin, "Programed Instruction in the Schools: An Application of Programing Principles in Individually Prescribed Instruction," in P. Lange, *Programed Instruction*, Sixty-sixth Yearbook of the National Society for the Study of Education, Part II, Chicago, Illinois, University of Chicago Press, 1967, pp. 217-254.

The challenge, then, is to find ways to recognize this kind of behavior in a student (and the recognition of its presence or absence is a kind of measurement), and to devise instructional situations which allow these objectives to be attained. The combination of the instructional background we provide in school plus the background that the student brings to school will determine whether these objectives are attained in minimal ways or ways that surprise us. At the very least, in the time we have available as teachers, objectives provide standards of competence which most students can reach and which many will surpass.

Diagnosis of Student Performance

Implicit in all that has been said so far is the necessity for information about student performance. In the absence of feedback, it seems impossible for the teacher to guide the student and for the student to guide himself about how well a desired performance is being approximated. Such information is the basis on which the teacher decides on the next instructional step; in addition, this information serves as reinforcing feedback for the student. It is also invaluable information for the design and redesign of teaching materials.

Evaluation for the purposes of curriculum design is becoming an increasingly important matter. Modern curricula will no longer be built solely on the basis of an author's judgment of the effective design of curriculum materials based on his general experience. Rather, curriculum development is guided by detailed empirical tryout and redesign on the basis of data obtained from student and teacher use. The performance of the student is observed and tested in order to analyze the strong points and shortcomings of an instructional sequence; the evidence obtained is used to improve it. The currently obtained effectiveness is then open for teachers to inspect. This process of evaluation for formative or design purposes will increase in the near future as educators demand such information.

Evaluation of the student's educational achievement requires an analysis of the nature of measures of student performance and the assessment of subject matter competence. An important distinction to make is that achievement measurement is distinguished from aptitude measurement in that the instruments used to assess achievement are specifically concerned with the properties of present performance, with emphasis on the meaningfulness of their content in relation to educational objectives. In contrast, aptitude measures derive their meaning from a demonstrated relationship between present performance and the future attainment of specified knowledge and skill.

The scores obtained from an achievement test can provide primarily two kinds of information: (1) the degree to which the student has attained a certain level of competence, for example, whether he can satisfactorily prepare an experimental report or solve certain kinds of problems in scientific reasoning; and (2) the relative standing of the student in a group, for example, whether Student A can solve his problems more quickly than Student B. The principal difference between these two kinds of information lies in the standard used as a reference. The standard against which a student's performance is compared in order to obtain the first kind of information is the criterion behavior which defines a specified educational objective. Criterion levels of competence can be established at any point in instruction where it is necessary to obtain information as to the adequacy of a student's performance. The student's score, with respect to these stated objectives, provides explicit information as to what he can or cannot do independent of reference to the performance of others.

On the other hand, when achievement measures are not referenced to objectives and convey only information about the capability of a student compared with the capability of other students, little information may be provided about the degree of proficiency exhibited by the tested behaviors in terms of what the individual can do. They tell that one student is more or less proficient than another, but do not tell how proficient either of them is with respect to the subject matter tasks involved. In large part, achievement measures currently employed in education are norm-referenced, and work needs to be done which will contribute to the development of criterion-referenced tests in order to assess the outcomes of learning. Criterion-referenced measures can provide information about both degree of competence and relative standing. This obviously requires both the specification of objectives and ways of evaluating their attainment.

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